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Spring 2-1-2019

# M 326.01: Number Theory

Matt B. Roscoe

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**NUMBER THEORY**  
MATHEMATICS 326 SECTION 1  
CRN 30070

INSTRUCTOR	Matt Roscoe Office: Math 213 Phone: (406) 243-6689 or (406) 203-2112 Email: matt.roscoe@umontana.edu
WEBPAGE	<a href="http://umonline.umd.edu/">http://umonline.umd.edu/</a>
GOALS	Upon completion of this course, a student will be able to: <ol style="list-style-type: none"><li>1. Construct mathematical proofs in number theory,</li><li>2. Explore the multiplicative structure of the integers,</li><li>3. Define congruence modulo <math>n</math>; and find solutions of linear congruences, quadratic congruences, and quadratic reciprocity,</li><li>4. Calculate values and properties of multiplicative functions (such as <math>\tau</math>, <math>\sigma</math>, <math>\mu</math>, and <math>\varphi</math>), and,</li><li>5. Find primitive roots of integers modulo <math>n</math>.</li></ol>
TEXT	<i>Elementary Number Theory</i> , 7th Ed., David M. Burton (ISBN 978-0-07-338314-9)
GRADING	25% homework exercises 15% mid-semester exam 1 15% mid-semester exam 2 15% mid-semester exam 3 30% cumulative final exam
HOMEWORK	<p>Working on problems seems to be the most important part of learning mathematics - take the homework seriously. Homework has to be turned in by 4PM on the due date. If you cannot hand it in on time for a “really good” reason, contact me, and I may be able to give you an extension. If I receive too many extension requests, I will have to change my policy and only grant extensions in cases of documented illness or other exceptional circumstances beyond your control. I encourage collaboration - by that I mean <i>working together</i> to solve problems, not simply copying the work of others. I require, however, the following:</p> <ol style="list-style-type: none"><li>1. You always have to write up your solutions in your own words.</li><li>2. You must indicate with whom you worked to solve the problem.</li><li>3. You are not permitted to use the internet as a solution resource.</li></ol> <p>Only a subset of the homework assigned will be collected for grading. Solutions to all the problems assigned will be posted on the course webpage on the day that the homework is collected. Because of this arrangement, you are asked to complete each homework problem on a separate piece of loose-leaf paper. Problems collected for grading will be assessed using the 4-point rubric provided below.</p>

MID-SEMESTER EXAMS	There will be 3 mid-semester exams. Exams will be closed book and closed notes. Each exam will consist of 4-6 problems. Problems on the mid-semester exam will be similar to those assigned in the previous weeks' homework. Each problem on each exam will be assessed using the 4-point rubric provided below.																																																																																				
FINAL EXAM	The cumulative final exam will be held on Tuesday, April 30, 3:20-5:20PM. The final exam will be closed book and closed notes. The final exam will consist of 8-12 problems. Problems on the final exam will be similar to those assigned in the homework across the semester. Each problem on the final exam will be assessed using the 4-point rubric provided below.																																																																																				
GRADE SCALE	<p>Let <math>S</math> be your weighted average in the course then,</p> <table><tr><td>93</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>100</td><td><math>\Rightarrow</math></td><td>A</td></tr><tr><td>90</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>93</td><td><math>\Rightarrow</math></td><td>A-</td></tr><tr><td>87</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>90</td><td><math>\Rightarrow</math></td><td>B+</td></tr><tr><td>83</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>87</td><td><math>\Rightarrow</math></td><td>B</td></tr><tr><td>80</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>83</td><td><math>\Rightarrow</math></td><td>B-</td></tr><tr><td>75</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>80</td><td><math>\Rightarrow</math></td><td>C+</td></tr><tr><td>70</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>75</td><td><math>\Rightarrow</math></td><td>C</td></tr><tr><td>65</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>70</td><td><math>\Rightarrow</math></td><td>C-</td></tr><tr><td>62</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>65</td><td><math>\Rightarrow</math></td><td>D+</td></tr><tr><td>58</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>62</td><td><math>\Rightarrow</math></td><td>D</td></tr><tr><td>55</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>58</td><td><math>\Rightarrow</math></td><td>D-</td></tr><tr><td>0</td><td><math>\leq</math></td><td><math>S</math></td><td><math>&lt;</math></td><td>55</td><td><math>\Rightarrow</math></td><td>F</td></tr></table>	93	$\leq$	$S$	$<$	100	$\Rightarrow$	A	90	$\leq$	$S$	$<$	93	$\Rightarrow$	A-	87	$\leq$	$S$	$<$	90	$\Rightarrow$	B+	83	$\leq$	$S$	$<$	87	$\Rightarrow$	B	80	$\leq$	$S$	$<$	83	$\Rightarrow$	B-	75	$\leq$	$S$	$<$	80	$\Rightarrow$	C+	70	$\leq$	$S$	$<$	75	$\Rightarrow$	C	65	$\leq$	$S$	$<$	70	$\Rightarrow$	C-	62	$\leq$	$S$	$<$	65	$\Rightarrow$	D+	58	$\leq$	$S$	$<$	62	$\Rightarrow$	D	55	$\leq$	$S$	$<$	58	$\Rightarrow$	D-	0	$\leq$	$S$	$<$	55	$\Rightarrow$	F
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HONESTY	<p>All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students need to be familiar with the Student Conduct Code. The Code is available for review online at the following web address:</p> <p><a href="http://life.umd.edu/vpsa/student_conduct.php">http://life.umd.edu/vpsa/student_conduct.php</a>.</p>																																																																																				
DISABILITIES	<p>The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors and Disability Services for Students (DSS). If you have a disability that adversely affecting you academic performance, and you have not already registered with DSS, please contact DSS in Lommassen Center 154 or 406.243.2243. I will work with you and DSS to provide an appropriate accommodation.</p>																																																																																				
DATES	<p>January 31st is the last day to drop or add the course using Cyberbear. March 15th is the last day to drop with instructor and advisor signatures (W appears on transcript). April 26th is the last day to drop the course or change grading option using a late drop form (WP/WF appears on transcript). Acceptable reasons for a late drop are listed in the university catalog and are limited to: accident, illness, family emergency or a change in work schedule. The following examples are not considered sufficient for a late drop: protecting GPA, forgetting to turn in the change slip, losing financial aid, losing eligibility to engage in sports.</p>																																																																																				

# SEMESTER SCHEDULE

Monday	Wednesday	Friday
Jan 7	Jan 9	Jan 11 Ch 1
Jan 14 Ch 1	Jan 16 Ch 2	Jan 18 Ch 2
Jan 21 MLK Day	Jan 23 Ch 2	Jan 25 Ch 2
Jan 28 Ch 2	Jan 30 Ch 2	Feb 1 Ch 2
Feb 4 Ch 3	Feb 6 Review	Feb 8 Exam 1
Feb 11 Ch 3	Feb 13 Ch 3	Feb 15 Ch 4
Feb 18 Presidents' Day	Feb 20 Ch 4	Feb 22 Ch 4
Feb 25 Ch 4	Feb 27 Ch 4	Mar 1 Ch 5
Mar 4 Review	Mar 6 Exam 2	Mar 8 Ch 5
Mar 11 Ch 5	Mar 13 Ch 6	Mar 15 Ch 6
Mar 18 Ch 6	Mar 20 Ch 6	Mar 22 Ch 6
Mar 25 Spring Break	Mar 27 Spring Break	Mar 29 Spring Break
Apr 1 Ch 7	Apr 3 Ch 7	Apr 5 Ch 7
Apr 8 Ch 8	Apr 10 Review	Apr 12 Exam 3
Apr 15 Ch 8	Apr 17 Ch 8	Apr 19 Ch 8
Apr 22 Ch 8	Apr 24 Ch 8	Apr 26 Review
<p>Final Exam</p> <p>Tuesday, April 30, 3:20-5:20PM</p>		

**A 4-Point Rubric for Mathematical Tasks** (Adapted From: Van de Walle, 2006)

Points	Characterization	Description
4	Excellent	Strategy and execution meets the content, processes, and qualitative demands of the task. Communication is effective, fluent and direct.
3	Proficient	Strategy and execution includes minor errors, and/or missing steps and/or faulty reasoning that requires more work than necessary for the reader to understand.
2	Marginal	Strategy and execution of the task is only partially accomplished and/or there is lack of evidence of understanding and/or there is evidence of not understanding.
1	Unsatisfactory	The task is attempted and some mathematical effort is made but there is little or no success.
0	No Attempt	The task is not attempted.

**A 4-Point Rubric for Mathematical Proof** (Adapted From: Devlin, 2015)

Points	Characterization	Description
4	Excellent	Other than perhaps a minor slip, the proof is complete and correct. The argument is clear and easy to follow. There is an opening statement, a statement of method (if appropriate) and a statement of conclusion. The mathematical reasoning is given for all significant steps.
3	Proficient	The proof is generally correct, but there is at least one significant error. The argument requires some effort to follow in some parts. The proof is missing an opening statement, a statement of method (if appropriate) or a statement of conclusion. Most of the significant steps are justified, but, at least one is not.
2	Marginal	The proof makes some progress, but, it is generally incorrect. There are multiple significant errors. The argument is hard to follow. The proof is missing two or more of the following: an opening statement, a statement of method (if appropriate) or a statement of conclusion. Multiple significant steps are not justified.
1	Unsatisfactory	The proof is only minimally attempted. Some mathematical effort is made but there is little or no success.
0	No Attempt	The task is not attempted.